

Preliminary Feasibility Study of
Resource Recovery Opportunities for
Tipton County, Tennessee

CSI Resource Systems, Inc.
Boston, MA

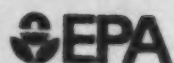
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A TECHNICAL ASSISTANCE PROGRAM REPORT

PRELIMINARY FEASIBILITY STUDY OF RESOURCE RECOVERY OPPORTUNITIES FOR TIPTON COUNTY, TENNESSEE

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Technical assistance by personnel teams. 42 USC 6913.

RESOURCE RECOVERY AND CONSERVATION PANELS

SEC. 2003. The Administrator shall provide teams of personnel, including Federal, State, and local employees or contractors (hereinafter referred to as "Resource Conservation and Recovery Panels") to provide States and local governments upon request with technical assistance on solid waste management, resource recovery, and resource conservation. Such teams shall include technical, marketing, financial, and institutional specialists, and the services of such teams shall be provided without charge to States or local governments.

This report has been reviewed by the Project Officer, EPA, and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

Project Officer: Elmer G. Cleveland

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PRELIMINARY FEASIBILITY STUDY
OF RESOURCE RECOVERY OPPORTUNITIES
FOR TIPTON COUNTY, TENNESSEE

PREPARED FOR
OFFICE OF SOLID WASTE MANAGEMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY, REGION IV

BY

CSI RESOURCE SYSTEMS, INC.

NOVEMBER 1980

PREFACE

This report was prepared for Tipton County, Tennessee, under the Technical Assistance and Panels Program, which is conducted by the U.S. Environmental Protection Agency (EPA) to provide assistance to state and local governments. Technical assistance was provided in response to requests submitted to U.S. EPA Region IV by Tipton County.

The report presents the results of a preliminary determination of the feasibility of resource recovery for the county. This determination involved an evaluation of the market potential for energy recovery; the development and evaluation of resource recovery alternatives; and the identification of the major tasks to be performed prior to deciding to implement a resource recovery project. These activities reflect the results of two site visits to Tipton County by CSI Resource Systems, Inc. (Resource Systems), and interviews with county and municipal personnel and three industrial energy users in the area.

Resource Systems is a technical assistance contractor to the Office of Solid and Hazardous Waste, U.S. EPA Region IV. Under the terms of the Technical Assistance and Panels Program, all of Resource Systems' technical assistance activities on behalf of Tipton County were paid for by EPA.

Resource Systems wishes to thank especially the following individuals for their support and generous cooperation: John Turner, Covington-Tipton Chamber of Commerce; Michael Berg, Engineering Manager, ESB, Inc.; Dieter Krachen, Vice President, Charms Company; Joe Cook, Plant Manager, Colonial Fiber; and Frank Victory, State of Tennessee Division of Solid Waste Management.

TABLE OF CONTENTS

	<u>Page</u>
CHAPTER 1. OVERVIEW.....	1
Findings/Conclusions.....	3
Immediate Next Steps.....	7
CHAPTER 2. EXISTING DISPOSAL SYSTEM.....	9
Existing Collection and Disposal Methods.....	10
Waste Generation Estimates.....	10
CHAPTER 3. MARKET INVESTIGATION.....	12
ESB Materials, Inc.....	13
Colonial Fiber.....	15
Charms Corporation.....	16
CHAPTER 4. TECHNOLOGY ASSESSMENT.....	18
Generic System Description.....	18
Preliminary System Definitions.....	20
CHAPTER 5. ECONOMIC ASSESSMENT.....	24
Methodology/Findings.....	25
Assumptions.....	28
APPENDIX A. STATE OF TENNESSEE RESOURCE AND ENERGY FACILITY PROGRAM	
APPENDIX B. ECONOMIC AND FINANCING ASSUMPTIONS AND PROJECTIONS	

CHAPTER 1. OVERVIEW

Tipton County, an area of 32,000 people, is located in the southwestern corner of Tennessee. The county encompasses eight incorporated areas, the largest of which is the city of Covington (population around 6,000); the remainder of the county is rural. Recognizing that the one county solid waste landfill has a limited remaining life, the county requested technical assistance from the U.S. Environmental Protection Agency (EPA) to evaluate the feasibility of resource recovery as a solid waste disposal alternative.

The prefeasibility study had two overall objectives: first, to quantify the waste supply and to conduct an energy market/site survey to determine, on a preliminary basis, whether or not any market/waste supply matches exist that would warrant technical and economic consideration; and second, if the findings are positive and if a project(s) appears to be technically and economically feasible, to identify those immediate next steps that should be performed prior to a commitment of significant additional resources for a comprehensive feasibility study.

The feasibility of resource recovery depends on the presence of five basic ingredients:

- Potentially viable energy buyers whose requirements would use all of most of the usable, or processible, solid waste generated.*
- A sufficient tonnage of processible solid waste from which enough energy and/or salable materials could be produced to meet the requirements of one or more potentially viable buyers.

* Processible solid waste is that tonnage of the total waste potentially available which could be processed in a resource recovery facility. Unprocessable materials include oversized, bulky waste (e.g., large metal objects, bed springs, rugs) and white goods.

- Potentially available sites that are well situated with respect to the shipment of solid waste and the delivery of energy to prospective buyers.
- Commercially available technologies that can reliably process available solid waste and produce energy and/or salable materials in the form, quality, and quantity required by prospective buyers.
- A total disposal cost that is competitive with the alternative disposal methods available to participating communities.

To assist Tipton County in establishing the feasibility of a resource recovery facility, the study initially focused on a review of the existing disposal system in order to develop a preliminary estimate of the amount of waste available for processing in a resource recovery facility and to establish the remaining useful life of the county landfill. The results of this task indicated that the county is not facing an imminent disposal problem (the remaining useful life of the county landfill is 10 years, assuming that planned development of an additional 30 acres occurs), and current disposal costs are relatively low.* It appears as though a sufficient tonnage of waste is available for processing in a resource recovery facility.

Because the conditions that typically prompt a municipally sponsored resource recovery project (rapidly diminishing landfill capacity and high disposal costs) do not appear to exist in Tipton County, the study focused on identifying viable resource recovery projects that could be sponsored by an entity other than the county (either the prospective energy buyer, or a combination of the buyer and the Covington Chamber of Commerce Industrial Development Commission). If the county were interested in sponsoring and owning a resource recovery facility, it could attempt to obtain financing under the State of Tennessee Resource and Energy Facility Loan Program. This financing source is only available for publicly sponsored and owned facilities. Appendix A summarizes the requirements of the state loan program. Whether a project were county-sponsored or not,

* Any existing or future solid waste disposal site is subject to stringent environmental requirements. This prefeasibility study did not address whether, in fact, the existing county landfill can achieve compliance and is, thereby, permitted to remain open over the next 10 years; nor did the study address the potential increases in landfill disposal costs that could arise because of the need to meet more stringent environmental requirements.

benefits (e.g., increased landfill longevity) could accrue to the county from a resource recovery project.

For illustrative purposes, it was assumed that for a Tipton County project to be economically feasible, the recovery facility should be capable of supporting itself through the revenues generated from the sale of recovered products. In other words, no tip fee (disposal charge) or other form of subsidy would be required. This assumed condition for economic feasibility is hereafter referred to as a zero tip fee.

In the remainder of this chapter, the study findings and conclusions are summarized, and immediate next steps are identified. Chapters 2 through 5 present the findings in more detail. Appendix B gives the assumptions used in and the findings of the economic assessment.

FINDINGS/CONCLUSIONS

The findings of the prefeasibility study indicate that, although a county-sponsored project is not likely given the anticipated 10-year existing remaining life of the county landfill and the relatively low cost of the existing landfill disposal system, two resource recovery alternatives that could be sponsored by other entities are feasible for Tipton County. This conclusion is based on the following:

- Tipton County has a sufficient tonnage of processible waste available (86 TPD₅,* or 20,640 tons per year) to support a small-scale resource recovery facility.
- The existing county landfill has an estimated life of 2 years; an additional contiguous 30 acres may be available for an expanded landfill disposal

* Tons available on a 5-day-per-week, 250-day-per-year basis.

operation, which, if occurring, could extend the useful life of the landfill to 10 years. Although this prefeasibility study did not specifically address the potential for increased landfill development and operation costs as a result of meeting the stringent environmental requirements mandated by the Resource Conservation and Recovery Act, it is likely that landfill disposal costs in Tipton County (currently estimated at \$3-\$5 per ton) will increase significantly.

- The Colonial Fiber plant in Covington is a potential existing buyer of waste-derived, high-temperature gas. Most of the company's average natural gas requirement (a total of 510,000 to 605,000 cubic feet per day) could be met by the energy content of the amount of processible waste potentially available in the county. In addition, the company's current fuel use (natural gas and No. 2 oil as backup) is compatible with the need to displace high-cost fuels in order to obtain adequate resource recovery project revenues. Also, Colonial has indicated that the company would consider financial participation in a resource recovery project (anywhere from purchasing the energy to equity participation) should the economics prove favorable. Finally, undeveloped land close to the plant and owned by Colonial Fiber is potentially available.
- The planned ESB Materials, Inc., plant (perhaps to be located in Covington) is a potential future buyer of waste-derived, low-pressure steam. If constructed, the new facility would have an average steam requirement (approximately 18,750 pounds per hour of low-pressure steam) that would be compatible with the amount of processible waste potentially available in the county. In addition, the company's planned fuel use (natural gas) would be compatible with the objective of displacing high-cost fuels with waste-derived energy. While ESB has not yet committed itself to building a new plant (nor has it decided where a new plant, were it to be built, would be located), ESB is considered a potentially viable future market, because: if built, the plant is likely to be located in one of

the two industrial plants in Covington where possible sites for a waste-to-energy plant exist; the company may not be able to obtain a commitment from the existing utility to provide natural gas to the new ESB plant; and ESB feels that the concept of a resource recovery facility is worthy of consideration. In fact, if ESB were unable to obtain a natural gas supply commitment from the utility, the availability of waste-derived process steam from a resource recovery facility could influence the company's decision to proceed with a new plant.

- A modular combustion unit (MCU) system with a design capacity of 100 TPD (two 50-TPD units) and an annual average throughput of 86 TPDs could be used to produce high-temperature gas in the case of Colonial Fiber or process steam in the case of ESB.* These systems would be processing just about all of the county's available waste. Because these systems were sized on the basis of preliminary waste supply and market demand estimates developed as part of this pre-feasibility study, the 100-TPD MCU-based systems should be considered as illustrative only. Should a decision be made to pursue one of these projects, further refinement of these estimates would be necessary.
- An MCU-based system to service Colonial Fiber (or ESB) is economically feasible at a zero tip fee under three of the four financing arrangements assessed [100-percent equity and several combinations of equity financing and industrial revenue bonds (IRBs)].**

* Design capacity is the manufacturer's rated capacity of the waste processing equipment. Annual average throughput is the amount of waste processed by the system on a 5-day-per-week basis averaged throughout the year.

** The economics of producing low-pressure and low-temperature process steam to service the future ESB plant were not specifically addressed as part of this study, because they would be similar to those for the MCU plant producing high-temperature gas.

- Because Colonial Fiber is located in the Covington North Industrial Park, the Covington Industrial Development Commission could support the issuance of IRBs, were either a straight IRB or a combined IRB/equity financing method selected. In the case of ESB, were the company to locate in either of the two industrial parks in Covington, the Industrial Development Commission could also support IRB issuance.
- An MCU-based system at either Colonial Fiber or ESB compares favorably with continued primary reliance on landfill disposal in several respects:
 - At a zero tip fee, the county would probably save on disposal costs by handling less waste at the landfill.
 - The life of the existing landfill could be extended by as much as 20 years.
 - Either Colonial Fiber or ESB would gain a cost-competitive and secure locally produced alternative energy source compared to its current reliance on natural gas.
 - In the case of ESB, the prospect that waste-derived process steam can substantially reduce the natural gas requirements of the proposed new manufacturing facility may be a significant factor in its decision to locate in the Covington area. If ESB does decide to locate its new manufacturing plant in Covington, both Covington and the county will benefit from the expanded tax base and the creation of additional industrial-sector jobs.
 - A resource recovery facility itself could create up to 10 new industrial-sector jobs.
 - If a resource recovery project were implemented in Covington, the Covington Industrial Development Commission's objective of industrial development would be furthered.
 - Resource recovery is an environmentally sound disposal method. By processing the majority of the waste in a resource recovery facility, the chance of groundwater pollution from a landfill would be reduced.

IMMEDIATE NEXT STEPS

The findings and conclusions summarized above are preliminary indications of project feasibility; further investigation is necessary to determine which project is preferred, and whether, in fact, either project can be implemented. Specifically, three critical tasks must be performed to verify the preliminary findings, before committing substantial resources to implement a resource recovery project. These next steps are:

1. Hold discussions with both Colonial Fiber and ESB in parallel to ascertain their level of interest and assessment of a resource recovery project in light of other investment opportunities. Obtain more detailed information on the companies' energy practices and requirements, including detailed energy load profiles showing hourly, daily, and seasonal variations; aggregate current and projected fuel costs; and electrical, water, and other utility charges.

The new ESB plant under consideration would have a manufacturing capacity three to four times that of the existing ESB plant. The county might consider stressing the fact that a secure and locally produced alternative energy source could be available to ESB if the company decided to locate a new plant in the county.

2. Establish a weighing and sorting program in Tipton County to ascertain that a sufficient amount of solid waste with a sufficient energy value is available to satisfy the requirements of the potential energy customer. In addition, determine the seasonal fluctuations in waste quantity and composition.
3. Determine whether the county controls the various portions of the waste stream generated within the county and develop strategies to ensure that the waste can be directed to a resource recovery facility.

If these three tasks confirm the feasibility of either or both of the identified projects, a detailed feasibility study should be performed. Given that a project, were it to be implemented,

would likely involve private-sector financing (with, perhaps, Industrial Development Commission support) of a facility using municipal solid waste, it seems appropriate that any additional work be a cooperative effort by Tipton County, the industry involved, and, if appropriate, the Covington Industrial Development Commission. Such a study will enable the industry, the county, and the commission to decide whether to proceed toward resolving project implementation issues, including system performance requirements, risk management, procurement, and financing.

In considering this project, Tipton County should also be aware that:

- A substantial portion of the solid waste stream will require ultimate landfill disposal, even if resource recovery is implemented. This portion may be as high as 35 percent on a tonnage basis (but only 10 to 20 percent on a volume basis, which is the critical measure for determining landfill requirements). This waste includes oversized, bulky materials and noncombustibles that are diverted from the project; residues of combustion; and processible wastes generated in excess of the energy requirements of the buyer.
- Whether resource recovery is implemented or not, the county landfill must achieve compliance with stringent environmental requirements if it is to continue operating.
- Development of an MCU system normally requires at least 24 months after procurement contracts are executed. This lead time suggests mid-1983 as the earliest date for a fully operational system.

CHAPTER 2. EXISTING DISPOSAL SYSTEM

The attractiveness of resource recovery for Tipton County depends, in part, on the extent to which the county faces a solid waste disposal problem, and on the economics of resource recovery as compared with alternative waste disposal methods (i.e., continued primary reliance on landfilling). To identify waste disposal problems, current solid waste collection and disposal practices were reviewed, and preliminary estimates of waste generation were developed. Current waste disposal costs were then estimated on a dollar-per-ton basis.

The review of the existing waste disposal system was based on information obtained from Covington Department of Public Works personnel during several visits to the county and from the Covington Director of Public Works. The review indicated the following:

- The majority of the waste generated is disposed of in a county-owned and operated landfill, located at the County Penal Farm, about 9 miles south of Covington. Assuming that planned development of an additional 30 acres occurs, the landfill will have a remaining useful life of around 10 years (if not, it has a remaining life of 2 years). Consequently, the county does not appear to face an imminent disposal problem.
- The county currently generates an estimated 108 TPD₅ of solid waste, of which an estimated 86 TPD₅ could be processed in a resource recovery facility.
- Current disposal costs at the landfill (estimated at \$3 to \$5 per ton) are low. However, while the county appears to enjoy relatively low landfill disposal costs at this time, these costs are likely to increase significantly as a result of having to meet more stringent environmental requirements.

In the remainder of this chapter, the existing system is described and the derivation of the waste generation estimates is given.

EXISTING COLLECTION AND DISPOSAL METHODS

As stated previously, the county is served by one landfill, owned and operated by the Covington Department of Public Works, and located just south of the city of Brighton at the County Penal Farm (about 9 miles south of Covington). In addition, the city of Covington operates a rubbish dump, where tree trimmings and small commercial-type wastes are delivered.

The two principal cities in the county, Covington and Mumford, operate municipal collection systems to collect residential, commercial, and industrial wastes. The remainder of the county is serviced by a county-operated green-box collection system, consisting of approximately 350 six- and eight-cubic-yard containers strategically located throughout the county.

WASTE GENERATION ESTIMATES

During a visit to the county, Department of Public Works personnel suggested that residential and industrial waste deliveries to the county landfill currently approximate 130 TPD₅. However, because the basis for this estimate was not given (and, hence, its accuracy could not be verified), conversations were held with the Covington Director of Public Works (Covington being the largest incorporated area in the county) to obtain information on the quality and characteristics of the waste generated in the city. According to this latter source, an average of 31 TPD₅ are collected in Covington. In addition, an average of 22 TPD₅ of tree trimmings and small commercial-type wastes are delivered to the Covington rubbish dump, for an estimated total of 53 TPD₅. By subtracting the Covington population (6,000) from the current estimated total

county population (32,000) and assuming a conservative per-capita waste generation rate of 3 pounds per day, it was possible to develop an estimate of the amount of waste generated in the remainder of the county -- 55 TPD₅. Of this combined estimated tonnage of 108 TPD₅, 90 percent of the Covington solid waste, 75 percent of the Covington rubbish, and 75 percent of the remaining portion of the county's waste were assumed to be processible, for a total estimate of around 86 TPD₅ of processible waste.*

The waste generation estimates developed as part of this study do not reflect seasonal variations in waste generation; nor do they provide for increases in future waste generation as a result of increased per-capita generation rates, population growth, or industrial development. Were a resource recovery project to be implemented, the impact of these factors on waste generation would need to be assessed.

The energy content of the waste (the higher heating value) was assumed to be 4,900 Btu per pound on the basis of work performed for other primarily rural areas of the county.

* The 75-percent processible estimate was based on waste stream characterization work performed in similar regions of the county.

CHAPTER 3. MARKET INVESTIGATION

Information obtained from the Covington-Tipton Chamber of Commerce indicated that three major industries, all of which are located in Covington, should be investigated as potential energy buyers.

These three industries are:

- Charms Corporation (steam)
- Colonial Fiber (high-temperature gas)
- ESB Materials, Inc. (steam).

All three firms were initially contacted by telephone to determine if their existing energy practices are compatible with resource recovery and to ascertain their interest in the concept. More detailed information on energy demand and possible interest in owning and operating a resource recovery facility was then obtained for all three firms during plant visits.

For purposes of marketing waste-derived steam, the most desirable steam customers require relatively low-pressure, low-temperature steam; have a relatively constant demand on a 24-hour-per-day, at least 5-day-per-week basis; and currently use high-priced fuels in their boilers. This latter characteristic is desired because the economic viability of resource recovery depends, to a great extent, on the revenues from the sale of the energy product. The price that can be obtained for the waste-derived energy is, in turn, dependent on the price of the fuel that it would displace. The most desirable customer for waste-derived gas has similar characteristics as those listed above, except that the steam conditions are not applicable in this case. For both types of customers, a potentially available site should exist nearby where a resource recovery facility could be located, and the customers should be located close to the centroid of the wasteshed.

On the basis of these desired characteristics and the amount of processible waste potentially available in Tipton County, the market survey indicated that both ESB and Colonial Fiber should

be considered as viable energy customers for steam and high-temperature gas, respectively. Because of its relatively low and noncontinuous steam demand (5,000 pounds of steam per hour, 2.5 shifts per day), Charms Corporation was eliminated from further consideration.

Each potential buyer investigated is described in greater detail in the remainder of this chapter.

ESB MATERIALS, INC.

Located in Covington for about 30 years, the ESB plant manufactures a manganese ore product and blended battery mixtures -- chemicals used in the production of several types of batteries. In an effort to improve production efficiency and expand capacity to meet market demand, ESB is currently in the process of selecting a site to locate a new facility (expansion of the existing facility is constrained by the residential development of most of the area surrounding the facility that has occurred over the years). It is envisioned that the existing facility, which operates 24 hours per day, 7 days per week, will continue to operate after the new plant is built. Should a new plant be built, it will have a production capacity of 3 to 4 times that of ESB's existing facility. However, it is not yet known whether this plant, if it were to be built, would be located in Covington.

Energy Practices

ESB currently purchases natural gas on an interruptible basis to raise low-pressure process steam in a 300-horsepower package boiler. In addition, the company has gas-fired dryers. The company's average hourly energy requirements are for 6,000 pounds of 54-psig steam (representing 85 percent of its total natural gas requirements) and for an estimated 1,250 cubic feet of natural gas for the dryers.

Assuming that the new facility is built, it would have a production capacity 3 to 4 times that of the current facility, such that its average hourly energy requirements would range from 18,000 to 24,000 pounds of process steam and from 3,690 to 5,000 cubic feet of natural gas for the dryers.

Resource Recovery Possibilities

Either low-pressure steam or high-temperature gas could be produced in a resource recovery facility using the processible waste potentially available in the county. However, preliminary analysis indicates that only 29 TPD₇ of the estimated total available tonnage of processible county waste (86 TPD₅, or 61 TPD₇) would be required to meet steam demand at ESB's existing plant. ESB's current high-temperature gas requirements (for drying applications) are an equivalent of only 8 TPD₇. These modest energy requirements, compounded by the likely difficulty in securing a nearby site, suggest that implementation of a resource recovery facility to meet ESB's current energy needs is impractical.

With respect to the possible new plant, however, indications are that the concept of a resource recovery facility to provide low-pressure steam is worthy of consideration. This possibility appears to be attractive for several reasons: the new plant's process steam requirements (equivalent to about 97 TPD₇, or 126 TPD₅) would be sufficiently large to use all of the steam that could be produced by a facility processing the county's estimated available tonnage of 86 TPD₅; if ESB were to locate this plant in Covington, it would likely be located in one of the two major industrial parks, where nearby vacant acreage is sufficient to house a resource recovery facility; ESB management has expressed concern regarding the possible difficulty in obtaining commitments from the existing utility for additional natural gas supplies; natural gas, the fuel that would be displaced by waste-derived

-15-

energy, is a high-cost fuel; and ESB management has expressed an interest in participating in a resource recovery project should the new facility be built and should the economics be attractive. For these reasons, the future ESB plant is considered a viable energy user.

COLONIAL FIBER

Also located in Covington (in the North Industrial Park), Colonial Fiber, a division of Lydall, Inc., manufactures various fiberboard products. Although produced from waste fiber, these products have strict quality requirements, must be moisture-absorbant and residue-free, and must meet the customer's color specifications. Current operations are 3 shifts per day, 5 days per week; during a healthy economy, production increases to 4 shifts per day, 7 days per week.

Energy Practices

Two natural-gas-fed, forced-air dryers are used to evaporate the excess moisture remaining after the waste fiber slurry is pressed. These dryers use No. 2 and No. 6 oil as a backup fuel. The plant's typical monthly natural gas requirements range from 11,000 to 13,000 million cubic feet (or approximately 510,000 to 605,000 cubic feet per day, on a 5-day-per-week basis).

Resource Recovery Possibilities

As energy represents a substantial portion of the product value and the fiberboard industry is very competitive, Colonial Fiber management is very interested in opportunities to reduce energy costs and, thereby, achieve a competitive advantage. In fact, the company is currently undertaking a comprehensive evaluation of its energy practices.

Most of Colonial Fiber's energy requirements for the drying process could be met by a resource recovery facility producing high-temperature gas and utilizing all of the estimated processible tonnage available (its average daily drying requirements are equivalent to approximately 88 to 103 TPD₅ of solid waste). In addition, Colonial owns from 10 to 15 acres of undeveloped land contiguous to its plant that could be suitable for locating a resource recovery facility. Siting a facility as close as possible to the drying operations could, however, necessitate moving three above-ground fuel oil storage tanks and two above-ground propane storage tanks. Finally, the Colonial Fiber Plant Manager indicated that, if the economic merits of using waste-derived energy appear to be worthwhile, Colonial management would consider various roles in the project, ranging from purchase of the energy to equity participation. For these reasons, a resource recovery facility to provide high-temperature gas to Colonial Fiber was carried forward in the prefeasibility analysis.

CHARMS CORPORATION

Located on a 20-acre site in the Covington North Industrial Park, Charms Corporation is a manufacturer of various hard candies. Current operations range from 2 to 2.5 shifts per day (the third shift is reserved for cleanup and housekeeping), 5 days per week. If warranted by market demand, future expansion of the Covington plant could occur.

Energy Practices

Two 300-horsepower Cleaver-Brooks boilers raise 150-psig steam and hot water. The steam is used to heat the various candies during the mixing process and to evaporate excess moisture to produce hard candy. During the winter, steam is also used in space-heating applications. Charms uses an estimated 5,000 pounds of steam per hour. The hot water (145°F) is used primarily for cleanup and housekeeping purposes.

Natural gas (purchased on an interruptible basis) is the primary fuel; No. 2 oil is the backup fuel. As of May 1980, the price of natural gas had increased substantially over 1978 prices paid by Charms.

Resource Recovery Possibilities

Recognizing the dramatic increases in its primary fuel costs, and anticipating a continuation of this trend, Charms management is interested in considering various options to reduce its energy costs, including the purchase of waste-derived energy. In addition, it appears that several sites on the undeveloped portion of Charms' property could be suitable for a resource recovery facility; another 6 to 7 acres (the former site of the city of Covington landfill) are located about 1,000 yards from the Charms plant. However, Charms' steam demand (on a 2.5-shift-per-day basis) is insufficient given the estimated tonnage of processible county waste available -- an equivalent of only 27 TPD₅ of solid waste would be used to service this manufacturing plant. For this reason, Charms was eliminated from further consideration in this prefeasibility study.

CHAPTER 4. TECHNOLOGY ASSESSMENT

Because the county only generates an estimated 86 TPD₅ of processible solid waste, a small-scale technology (an MCU-based system) was assessed as a reference system for both the ESB steam market and the Colonial high-temperature gas market. This assessment indicated that an MCU-based system is technically feasible for either project opportunity.

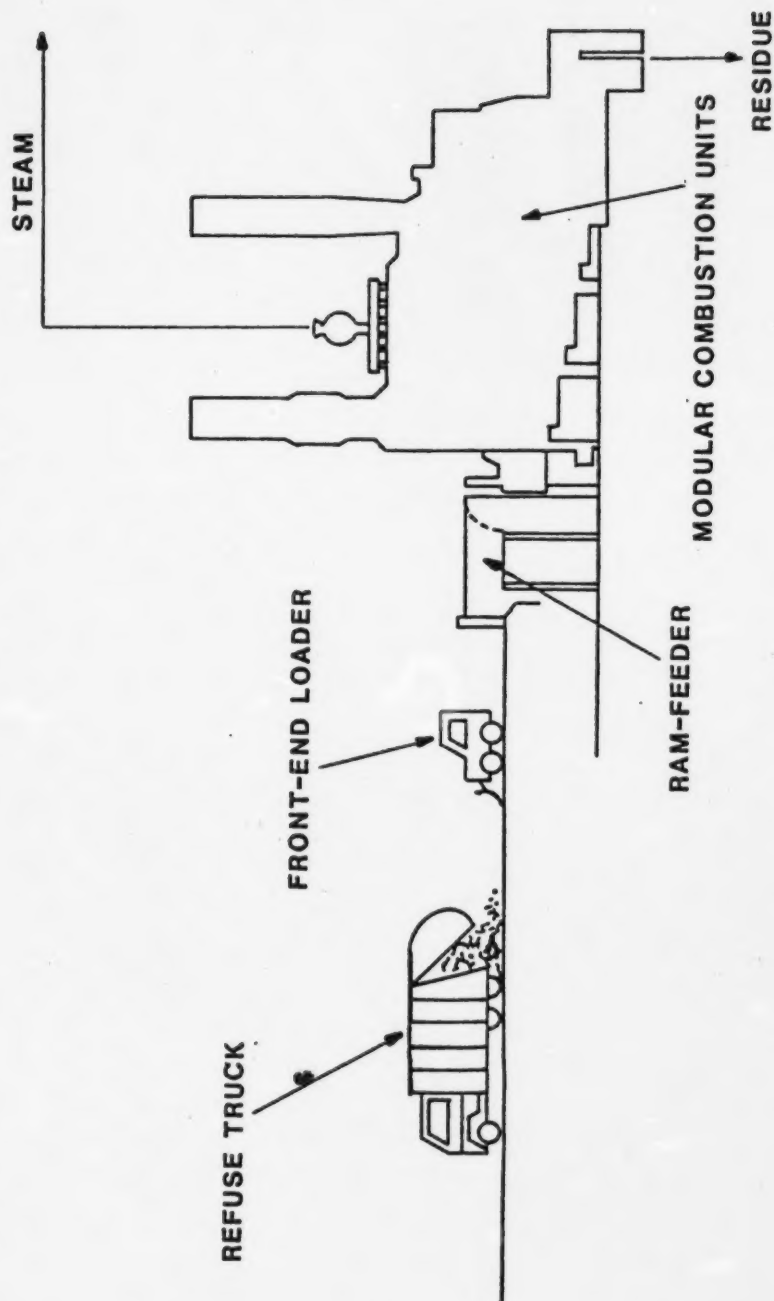
MCU-based systems are operating successfully in a number of cities, including North Little Rock, Arkansas; and Salem, Virginia. These units, which are modular in design, can be grouped in numerous configurations to permit a waste processing design capacity ranging from less than 100 TPD to 400 TPD (individual unit sizes of 10 to 75 TPD). Within the 100-TPD to 300-TPD processing range, these MCU-based systems offer a cost advantage (in terms of cost per installed ton of capacity) over the more conventional field-erected mass-burning waterwall or refractory-lined combustion equipment.

In the remainder of this chapter, a generic description is given of an MCU waste processing operation, followed by a preliminary system definition for both options.

GENERIC SYSTEM DESCRIPTION

Whether the MCU-based resource recovery system were producing steam or high-temperature gas, the operation of the waste-processing subsystem would be similar. Figure 1 provides a simplified diagram

FIGURE 1
MODULAR COMBUSTION UNIT



of an MCU. As shown in this figure, waste is delivered to the resource recovery facility, onto a concrete loading floor. Unprocessable materials (e.g., large metal objects, water heaters, rugs) are removed and placed in residue containers for sale as scrap or for disposal in a landfill. A front-end loader is used to push the remaining solid waste into a hopper, and a hydraulic ram-feeder moves the waste into the incinerator's lower chamber where it is partially burned. The heat released provides the energy needed to dry and gasify the remaining waste. The carbon-monoxide-rich smoke leaves the top of the lower chamber and enters into the secondary chamber; there, more air is added, and the gases are burned to completion. As the hot gases exit the secondary chamber, they pass through a heat exchanger, where the heat in the exit gases is converted to steam.* The stack gases are then discharged to the atmosphere.**

Ash consisting of glass, stone, metals, inert solid waste, and residual carbon char is moved from the bottom of the lower chamber into an ash disposal system. A magnet that recovers magnetic metals for sale to the secondary metal market can be installed. The remaining ash is loaded into a truck for disposal at a landfill.

PRELIMINARY SYSTEM DEFINITIONS

In the following subsections, initial system definitions are given for resource recovery facilities to service the two markets

* When the energy form delivered is hot gas, rather than steam, an air-to-air heat exchanger (rather than a boiler) is used as the heat exchanger, or the heat exchanger is eliminated altogether and the buyer uses the hot gases directly.

** Particulate emission control is usually provided for in the design of the unit. However, increasingly stringent air pollution regulations will likely require the installation of electrostatic precipitators on MCUs.

identified as potentially viable in the last chapter. Because of the preliminary nature of the waste and market data, these systems should be considered as illustrative only.

ESB Materials

A 100-TPD (two 50-TPD units) MCU-based system would produce 150-psig steam for sale to the ESB facility now under consideration. In sizing this conceptual system, the following assumptions were used:

- The higher heating value/energy content of the county's waste is 4,500 British thermal units per pound.
- System efficiency is 60 percent.
- Each unit has a 90-percent availability.
- Steam output is 4,600 pounds per ton of waste with no condensate return.
- 150-psig steam is produced.
- The system operates 24 hours per day, 5 days per week, 250 days per year.*
- Annual average system throughput is 86 TPD₅, or 21,500 tons per year.
- The new ESB manufacturing plant (which would operate 7 days a week) would generate steam in in-house boilers on the 2 days a week that the resource recovery system would not be operating (and during week days when demand is not satisfied).
- No redundancy is included, so that when the resource recovery system is down, the waste bypasses the facility and goes directly to the landfill. During recovery system outage, ESB in-plant boilers would be used to generate steam.

Because the steam requirements of the ESB facility would exceed the amount of steam that could be produced using all of the estimated processible tonnage available in Tipton County, the major

* Although the ESB plant would operate 7 days per week, because waste would only be delivered to the facility 5 days per week, 7-day-per-week resource recovery plant operations are not possible.

factor affecting system sizing was the amount of waste available, not the energy demand of the market being serviced.

To service the market, a steam transmission line would have to be constructed running from the resource recovery facility to the ESB plant. The length of this pipeline (which would have to be within a 2-mile radius because of thermodynamic and economic constraints) would depend on where the new manufacturing plant was located and its proximity to an available site.

When processing 86 TPD₅ of solid waste, the MCU-based plant would have an average hourly output of approximately 16,500 pounds of steam (it is expected that the new ESB facility would have average hourly steam requirements of 18,000-24,000 pounds of steam 7 days a week). Consequently, ESB would have to use in-house boilers to meet daily steam requirements in excess of the output of the resource recovery facility, as well as to meet total steam requirements on those 2 days that the resource recovery plant would not be operating.

Colonial Fiber

In this case, a 100-TPD (two 50-TPD units) MCU-based system would produce high-temperature gas for sale to Colonial Fiber. Because Colonial Fiber could use almost all of the gas that could be produced, the major factor affecting system sizing was the estimated amount of processible tonnage, not market demand.

In selecting this conceptual system size, the following assumptions were used:

- The higher heating value of the county's waste is 4,500 Btu per pound.
- An air-to-air heat exchanger is used such that system efficiency is 60 percent.
- Each unit has a 90-percent availability.

- The system operates 24 hours a day, 5 days per week, 250 days per year.
- Annual average system throughput is 86 TPD₅, or 21,500 tons per year.
- No redundancy is included, so when the resource recovery facility is down, the waste bypasses the facility and goes directly to the landfill. During recovery system outage, Colonial would have to use natural gas to run its dryers.

Because Colonial must meet strict product quality requirements, the system includes an air-to-air exchanger to avoid direct contact by the waste-derived hot gases with the fiberboard in the dryers. If in field trials at the Colonial Plant, it was found that direct contact with exhaust gases did not contaminate the fiberboard, the air-to-air heat exchanger could be eliminated and the products of combustion, suitably diluted to the required temperature, introduced directly into the dryers through injection ports. Direct venting would reduce system costs and could increase system efficiency from 60 percent to ± 90 percent, depending on the distance that the hot gases had to be transported.

The MCU-based system would be located on Colonial-owned land contiguous to the manufacturing plant (preferably within a few hundred feet of the drying operations) to maximize energy efficiency.

The production of waste-derived hot gases in an MCU-based system with an air-to-air heat exchanger has been successfully demonstrated in an industrial application using industrial wastes (i.e., at the John Deere plant in Wisconsin). While use of an MCU-based system burning municipal waste to produce hot gases for sale has not been demonstrated, because the waste gases from municipal and industrial waste combustion are similar, no unusual problems are anticipated with this resource recovery option.

CHAPTER 5. ECONOMIC ASSESSMENT

Because ESB's plans for building a new manufacturing facility are uncertain, the preliminary economic estimates were only developed for the MCU-based system producing high-temperature gas for sale to Colonial Fiber. However, the estimated economics for a plant selling waste-derived steam to a new ESB facility would be similar to those estimated for Colonial Fiber.*

As discussed previously, because the county is not facing an imminent waste disposal problem, either in terms of landfill capacity or disposal costs, for purposes of analysis, preferred resource recovery options were assumed to be those that can support themselves through energy revenues (i.e., no tip fee or other form of subsidy is required) and that could be sponsored by an entity other than the county.

The preliminary economic assessment indicated that an MCU-based 100-TPD system to service Colonial Fiber would have a projected tip fee of zero beginning with the first year of commercial operations (1983) under three of the four financing arrangements assessed:

- 100-percent equity
- 50-percent equity/50-percent IRB
- 25-percent equity/75-percent IRB.

Under 100-percent equity financing, the projected annual average return on investment (internal rate of return) is around 13 percent.** At 50-percent equity/50-percent IRB and 25-percent equity/75-percent IRB, the estimated annual average returns on investments are around 14 percent and 25 percent, respectively.

* The ESB capital cost estimates could be slightly higher, depending on the length of the steam transmission line.

** The projected return on investment for each financing method considered is on an after-tax basis.

In the remainder of this chapter, the methodology used to conduct this prefeasibility economic assessment, the study-level economic estimates developed for the Colonial Fiber project, and the assumptions used are summarized. Appendix A gives a more detailed description of the assumptions used in this initial analysis.

METHODOLOGY/FINDINGS

To date, IRBs and general obligation bonds (GOBs) have been the principal instruments used to finance resource recovery projects. However, because this analysis assumes private sponsorship of the project, GOBs are not applicable in this case. One-hundred percent equity financing, which allows greater control and flexibility and is more expeditious than IRBs, is becoming a more common method of privately financing small-scale resource recovery facilities. These advantages occur because project responsibility is not shared with a public sector entity and because it is not necessary to go through the procedures of underwriting a bond issue. In addition, various combinations of equity and IRB financing are being used. Because total capital and debt service requirements (and, thus, net disposal costs) are greatly affected by the financing method used in the preliminary economic assessment, four alternative financing arrangements were considered. These are:

- 100-percent equity
- 50-percent equity/50-percent IRB
- 25-percent equity/75-percent IRB
- 100-percent IRB.

The 100-TPD MCU project (average annual throughput would be 86 TPD₅) was evaluated under these various financing arrangements using a discounted cash flow analysis and assuming that mid-1983 would be the start of the first year of facility operation.

On the basis of conservative assumptions regarding project revenues and costs (discussed in the next section), an annual average after-tax return on investment of about 13 percent was estimated for the 100-percent equity case. In other words, indications are strong that, under this financing arrangement, the project would be economically self-supporting immediately. It should be noted that, were Colonial to undertake 100-percent equity financing of the resource recovery project, the implementation period (development, design, construction, startup, and acceptance testing) could be shortened by as much as 1 year. This would, in turn, expedite the cash flow with corresponding increases in the return on investment.

The economic estimates for the two equity/IRB combinations considered also indicate project feasibility assuming a zero tip fee beginning the 1st year of commercial operations. For the 100-percent IRB alternative, a net disposal cost (costs minus revenues) was estimated for the 1st and 6th year of operations. The table below summarizes the preliminary findings under all four financing options.

Financing Option	Projected Tip Fees 1983 1988 (\$/ton)		Year Project Becomes Self- Supporting (i.e., a zero tip fee is achieved)	Projected Annual Average After- Tax Return on Investment
100% Equity*	0.00	0.00	Immediately	12.5%
50% Equity/ 50% IRB	0.00	0.00	Immediately	14.1%
25% Equity/ 75% IRB	0.00	0.00	Immediately	26.0%
100% IRB**	18.61	8.32	1992	N.A.

* Assumes no discount on fuel.

** Assumes a 10-percent discount on fuel.

The preliminary projections developed under the 100-percent IRB financing alternative indicate that operating and maintenance and debt service expenses will exceed project revenues for the period of early 1983 to early 1992 (up to the 10th year of commercial operations). By early 1992, the revenues will begin to exceed expenses, i.e., profits will be generated. Consequently, under this financing approach, preliminary indications are that either a tip fee would be required to make up the revenue shortfall or the energy buyer would have to subsidize the product (e.g., by paying a premium price for the energy purchased) up until the 10th year of operation. It should be pointed out, however, that were the prospective energy customer to assume "constructive ownership" of the resource recovery facility by guaranteeing the debt service payments of the entire bond issue, the tax benefits available in the form of the 10-percent investment tax credit and the depreciation tax shield could exceed the amount of subsidy required during the first 9 years of operation. (The analysis performed under the 100-percent IRB financing with private-sector "constructive ownership" indicates that project cash flows are positive over each year of the project's expected life).

Under the 25-percent equity/75-percent IRB financing alternative, preliminary indications are that, because of the significant depreciation tax shelter, even when nondiscounted fuel prices are assumed, the resource recovery facility would provide a very attractive annual after-tax return on investment of around 26 percent. In the 50-percent equity/50-percent IRB case, the annual overall after-tax return on investment was estimated to be around 14 percent. If Colonial were to implement a resource recovery project using either of these two financing combinations, the company could use the lower interest IRBs as leverage, and obtain a higher return on investment from a much smaller investment.

There are certain advantages to the 25-percent, 50-percent, and 100-percent equity approaches; obviously, the decision would be Colonial's as to which approach it might choose.

ASSUMPTIONS

The assumptions used in developing the economic projections (system cost and revenue estimates) are summarized briefly in the following subsections.

Projected System Costs

The 1980 capital costs of an MCU-based system were developed from engineering estimates and recent bids submitted by full-service system vendors. These costs were then projected to early 1982 (assumed to be the midpoint of the 18-month design/construction phase) at a compounded annual escalation rate of 14 percent. System operating costs were assumed to escalate at an 8-percent rate. To project the rate of return for the 100-, 50-, and 25-percent equity cases, a straight line, 15-year depreciation* was assumed with a 45-percent corporate income tax rate.

Projected Revenues

In projecting energy revenues, the following assumptions were made:

- The price of the resource recovery facility's energy output reflects, on a Btu-equivalent basis, the price of the fuel displaced less a 10-percent discount for the 100-percent IRB case. For the 25-percent, 50-percent, and 100-percent equity cases, no fuel discount was assumed. Thus, in these latter three cases, the additional revenue accrues to Colonial as part of the overall return on the investment.
- The displaced fuel was assumed to be natural gas with an average 1980 cost equivalent of \$0.70 per gallon for 1-percent sulfur No. 6 oil, escalated at a compounded annual rate of 10 percent.
- High-temperature gas sales were assumed to occur 250 days per year to allow for scheduled and non-scheduled outages at Colonial and at the resource recovery plant.

* The IRS has ruled that for tax purposes a resource recovery facility under private-sector ownership can be depreciated over a 7-year, 8-month period by using any acceptable depreciation method, including accelerated depreciation.

APPENDIX A.
STATE OF TENNESSEE RESOURCE AND
ENERGY FACILITY LOAN PROGRAM

In this appendix, the main features and requirements of the State of Tennessee Resource and Energy Facility Loan Program are summarized.

The state loan program is used to finance facilities that recover energy or materials from municipal solid waste. As such, it may be appropriate for financing a Hawkins County project.

The loan program incorporates aspects of both GOB and IRB financing. The state issues bonds and then loans the bond proceeds to the sponsor of an eligible project. The bonds, which are issued and sold by the state (i.e., the state acts as bond underwriter), enjoy tax-exempt status, as well as, the full faith and credit backing of the state. In order for a project to be considered for financing under the program, it must have demonstrated economic and technical merit. Thus, while the bond issue is sold on the basis of a GOB, with the resultant low interest rates, in essence the project must meet the strict credibility guidelines typical of IRB-type financing.

ELIGIBILITY

Several project eligibility criteria have to be met. First, at least 60 percent of the materials or energy content of the municipal solid waste stream has to be recovered and sold. Second, 50 percent or more of this quantity of materials or energy has to be spoken for by at least a letter of intent from prospective customers. Third, facilities that will convert the municipal solid waste must be owned by public-sector entities (i.e., a municipality, a regional entity, or a solid waste authority). Fourth, prior to receiving initial commitment as to loan availability, a prefeasibility study must be submitted that demonstrates the technical and economic merit

of the project. Once initial commitment is made by the Tennessee state program and prior to bond proceeds being received, a more detailed feasibility analysis is required (similar to that required by an investment banking firm for similar type projects). The pre-feasibility study indicating initial technical and economic merit must be submitted to the Tennessee State Department of Public Health by January 15 of the year in which the proceeds are being requested.

KEY FEATURES

Interest rates are likely to be similar to those associated with GOB financing. However, because of the uncertainties in the marketplace at the present time, it is not possible to estimate what the interest rate may be.

Bond issue is predicated under a sinking-fund-type of arrangement with the term of the bond issue not to exceed the expected useful life of a facility. For an MCU-based system, the assumed useful life is around 15 years.

Given the uncertainty associated with the capital cost projections for any resource recovery project, inclusion of a contingency fund is strongly recommended.

Interest payments during construction and startup are similar to GOB or IRB financing, and are to be capitalized and incorporated into the bond issue. It appears that a debt service reserve fund is not necessary.

While the project must be owned by a public-sector entity, there appears to be flexibility regarding operation; if appropriate, it appears that a facility could be operated by a private-sector firm under contract to the public-sector owner.

APPENDIX B.
ECONOMIC AND FINANCING
ASSUMPTIONS AND PROJECTIONS

In this appendix, the assumptions used and the projections made in the preliminary economic analysis are given. The economic and financing assumptions are listed in Tables B-1 and B-2, respectively. The estimated operating and maintenance costs are given in Table B-3 for a 100-TPD MCU-based system. Table B-4 gives estimated labor requirements and costs for the same sized MCU-based system. In Tables B-5 through B-8, the estimated capital requirements are given for the four alternative financing arrangements considered in this study, assuming the 100-TPD MCU-based system.

TABLE B-1
ECONOMIC ASSUMPTIONS

- Annual escalation rates:
 - 10 percent for capital costs to midpoint of construction (1982)
 - 10 percent for energy revenues
 - 8 percent for operating costs.
- Energy values received for displaced energy:
 - 10-percent discount for 100-percent IRB case
 - No discount for 25-, 50-, and 100-percent equity cases.
- Value of high-temperature gas in mid-1983 is \$6.78/million Btu (or an equivalent of \$0.93/gallon of 1-percent sulfur No. 6 oil).

TABLE B-2
FINANCING ASSUMPTIONS

100-Percent IRB

- 17-year bond issue; interest payments only during 2-year construction and startup period.
- 9-percent interest.
- Debt service reserve account: a reserve fund equal to 1 year's debt service.
- Capitalized interest account: a reserve fund to meet interest payments on bonds during construction and startup, when energy revenues are not available.
- Bond financing: bond issue costs and underwriter fees equivalent to 3 percent of total bond issue.

25-Percent Equity/75-Percent IRB

- Equity investment equivalent to 25 percent of capital, contingency, and engineering costs.
- Other assumptions identical to those for 100-percent IRB financing.

50-Percent Equity/50-Percent IRB

- Equity investment equivalent to 50 percent of capital, contingency, and engineering costs.
- Other assumptions identical to those for 100-percent IRB financing.

100-Percent Equity

- Equity investment comprises capital, contingency, and engineering costs.
- No requirement for debt service reserve account, capitalized interest account, and bond financing.

TABLE B-3
ESTIMATED OPERATING AND MAINTENANCE COSTS
FOR 100-TPD MCU-BASED SYSTEM
(AVERAGE THROUGHPUT 86 TPD₅)

	1983	1988*
Labor	\$ 244,000	\$ 344,000
Maintenance and Replacements ¹	\$ 150,000	\$ 220,000
Utilities	\$ 50,000	\$ 74,000
Insurance ²	\$ 75,000	\$ 110,000
Residual disposal	N.A.	N.A.
Taxes	N.A.	N.A.
Operator profit ³	\$ 55,000	\$ 81,000
Total Operating Expenses	<u>\$ 574,000</u>	<u>\$ 829,000</u>

* All cost elements escalate by 8%/yr.

1. 5% of combustion system capital costs.

2. 2% of system capital costs.

3. \$2.50/ton operator profit.

TABLE B-4
ESTIMATED LABOR REQUIREMENTS FOR
100-TPD MCU SYSTEM

<u>Position</u>	<u>Number of Employees</u>	<u>Employee Salary*</u>	<u>Subtotal</u>
Plant Manager	1	\$25,000	\$ 25,000
Scale Operator/Clerk	1	13,500	13,500
Operators	3	16,000	48,000
Shift Managers	4	13,500	54,000
Ash Truck Driver	1	13,500	13,500
Maintenance Mechanic	1	19,000	19,000
Electrician**	<u>1/2</u>	15,000	<u>15,000</u>
TOTAL EMPLOYEES	11 1/2		
DIRECT LABOR EXPENSES			\$188,000
FRINGE BENEFITS (@ 30%)			<u>56,000</u>
TOTAL LABOR EXPENSES:			\$244,000

* 1983 dollars.

** Contract employee.

TABLE B-5
ESTIMATED CAPITAL REQUIREMENTS UNDER
100% EQUITY FINANCING (1983 \$ 000)

System Capital Costs ^A	\$4,175
Contingency ^B	\$ 420
Engineering/Legal Consulting	<u>\$ 100</u>
SUBTOTAL	\$4,695
Equity Contribution	\$4,695
TOTAL FINANCING REQUIREMENTS	\$4,695

A. Includes site acquisition and development; combustion sub-systems; building; mobile equipment; and engineering design and construction management.

B. Contingency is 10 percent of system capital costs.

TABLE B-6
ESTIMATED CAPITAL REQUIREMENTS UNDER
50% EQUITY/50% IRB FINANCING
(1983 \$ 000)

System Capital Costs ^A	\$ 4,175
Contingency ^B	\$ 625
Engineering/Legal Consulting	<u>\$ 100</u>
SUBTOTAL	\$ 4,900
Equity Contribution ^C	⟨\$ 2,450⟩
Capitalized Interest During Construction and Startup	\$ 0
Debt Service Reserve Fund ^D	\$ 320
Bond Financing Costs ^E	\$ 85
Bond Issue	\$ 2,855
TOTAL FINANCING REQUIREMENTS	\$ 5,305

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- A. Includes site acquisition and development; combustion subsystems; building; mobile equipment; and engineering design and construction management.
- B. Contingency is 15 percent of system capital costs.
- C. Equity contribution is equal to 50 percent of the capital cost subtotal.
- D. Debt service reserve fund is equal to 1 year's debt service reserve.
- E. Bond financing costs are equal to 3 percent of the bond issue.

TABLE B-7
ESTIMATED CAPITAL REQUIREMENTS UNDER
25% EQUITY/75% IRB FINANCING
(1983 \$ 000)

System Capital Costs ^A	\$ 4,175
Contingency ^B	\$ 625
Engineering/Legal Consulting	\$ 100
SUBTOTAL	<u>\$ 4,900</u>
Equity Contribution ^C	<\$ 1,225>
Capitalized Interest During Construction and Startup	\$ 0
Debt Service Reserve Fund ^D	\$ 478
Bond Financing Costs ^E	\$ 128
Bond Issue	\$ 4,280
TOTAL FINANCING REQUIREMENTS	\$ 5,505

A. Includes site acquisition and development; combustion subsystems; building; mobile equipment; and engineering design and construction management.

B. Contingency is 15 percent of system capital costs.

C. Equity contribution is equal to 25 percent of the capital cost subtotal.

D. Debt service reserve fund is equal to 1 year's debt service reserve.

E. Bond financing costs are equal to 3 percent of bond issue.

TABLE B-8
ESTIMATED CAPITAL REQUIREMENTS UNDER
100% IRB FINANCING
(1983 \$ 000)

System Capital Costs ^A	\$ 4,175
Contingency ^B	\$ 625
Engineering/Legal Consulting	<u>\$ 100</u>
SUBTOTAL	\$ 4,900
Equity Contribution	\$ 0
Capitalized Interest During Construction and Startup	\$ 335
Debt Service Reserve Fund ^C	\$ 682
Bond Financing Costs ^D	\$ 183
Bond Issue	\$ 6,100
TOTAL FINANCING REQUIREMENTS	\$ 6,100

A. Includes site acquisition and development; combustion subsystems; building; mobile equipment; and engineering designs and construction management.

B. Contingency is 15 percent of system capital costs.

C. Debt service reserve fund is equal to 1 year's debt service reserve.

D. Bond financing costs are equal to 3 percent of bond issue.